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CONTENTS

A Glance at the Zoology of Today. *H. V. Wilson* 83

A List of Syrphidæ of North Carolina. *C. L. Metcalf* 95

On the Occurrence and Distribution of Potassium in Normal and Nephropathic Kidney Cells. *Wm. deB. MacNider* 113

Professor Cain's Contributions to the Scientific Study of Earth Pressure: A Pioneer Work. *Archibald Henderson* 115

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JOURNAL
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Elisha Mitchell Scientific Society

Volume XXXII DECEMBER, 1916 Number 3

A GLANCE AT THE ZOOLOGY OF TODAY[1]

By H. V. Wilson.

When zoology is mentioned, our first thoughts turn to the different kinds of animals, to the so-called species; to the birds and insects round our homes, to the fish we have caught; to the less familiar forms of the coast, the sponges, medusæ, and corals; to the beasts we have seen in zoological gardens, to the specimens exhibited in museums. This richness in variety is pleasing to most of us, and it is small wonder that the work of collecting and describing has been so actively pursued. The forms of animal life sufficiently different to be enrolled as separate species now number about half a million.

Strange as it may seem, one still at intervals hears the question, "What is the use of all these creatures?" meaning their use to us, to man. Perhaps the question is never very seriously asked today. For we all know a long list of organisms who, if they bring us tribute, bring a strange kind. We think of that prince of evil, the tiger; of the cobra; of parasitic worms that bore through the living flesh; of bacilli that bring disease after disease; of protozoa that cause malaria and sleeping-sickness. And we recognize that the material world is not obviously anthropocentric.

Modified, however, the question is a very rational one: what forms are inimical to us, what forms directly or indirectly useful? This question, essentially economic and hygienic, tends greatly to increase our interest in natural history, in the knowledge of the kinds of animals, and the changes of form, habit, and home which they un-

[1]An address delivered, as Southern Exchange Lecturer for 1915-16, before the students of the University of Virginia, April 4, 1916. Reprinted from the *Scientific Monthly* for September, 1916.

dergo during individual life. We become aware how complex are the interdependencies of organisms, how interwoven are their life histories. We find that it is largely on such knowledge that the medical scientist and the sanitary engineer draw when they seek to combat the infectious diseases, and how vitally helpful such knowledge is to the various branches of animal industry.

These considerations show us plainly enough that biology is useful, and in making this statement we perhaps express the real nature of our knowledge in general, as something not final and comprehensive, but detailed and practical. Let us, however, not confound this aspect of the nature of knowledge with the method of science. Because the world is so ordered, and its ways so interconnected, that any or all knowledge may after a time prove useful, is no reason why we should concentrate our attention chiefly on tasks and problems that are of immediate practical importance. On the contrary, as we survey the history of science, we see clearly that inquiries into the causes or beginnings of things, irrespective of direct utility, are of the first importance. It is these which lead to the emergence of the great general ideas, which, in their turn, light the way to the discovery of special facts that are of direct utility.

Turning from the utilitarian aspect of biology, let us take up for a moment a problem which, never new, is yet always interesting. What is the origin of all these forms that we have learned to know? What is the nature and origin of species, or, choosing the phraseology of the day, of specific differences?

In the histories of the theory of evolution we read, wondering if any of our present-day notions shall prove as untenable, that Linnæus held that species were changeless, that they were in character and number precisely as originally created. We read that somewhat later, when fossils were better known, Cuvier interpreted the present organisms and the very different ones of past geological periods as the results of separate acts of creation, each period with its living things coming to an end in some tremendous catastrophe. And that still later Louis Agassiz held the same view, while meantime he with many others paved the way for evolution by discoveries of fact, bringing to light the existence of fossil series from low forms to high, and

many illustrations of the generalization embodied in our "biogenetic law" of today, namely, the generalization that organisms do not pursue a straight path of development from egg to final form, but commonly develop temporary peculiarities of structure constituting resemblances to lower forms.

The strong tide of evolutionary doctrine that set in with the publication of Darwin's great book in 1859 brought nothing new to what had been taught by Louis Agassiz as regards the existence of the resemblances, just alluded to, between organisms, adult, embryonic and fossil. But that the stream of living matter has been continuous from generalized type to derived form, or, as we say, from ancestral type to descendant, this is the conception that rings out the note of difference from Agassiz's teaching. Basing its argument on minor mutability that can be demonstrated and on a mass of circumstantial evidence, overpowering in its cumulative effect, evolution claimed that fundamental resemblance is not a transcendental likeness, but is due to kinship. With this conclusion we are long familiar. It has entered into the very marrow of our mental life, and everything that we learn corroborates it. The conclusion concerns us in a direct way, for the evolutionary process cannot be thought of as something finished and done with. Rather do we conclude that if organisms *have* changed, they are still changing.

Granted the fact that organisms change, the question veers and we ask in response to what do they change? Are the changes natural phenomena throughout and, as such, due to natural causes, like the up and down heaving of the earth's crust?

We are confronted today, as in past times, with two interpretations of nature. On the one side argument, clad in the robe of philosophy, would lead us beyond the border of the phenomenal world, seeking a reality on which all phenomena are dependent. Many tell us there is such a reality—and certainly nothing that we know contradicts them. On the other hand, the obvious world is a world of natural phenomena, which, although at bottom incomprehensible, prove on study to be orderly and predictable. That is, we learn through experience that one occurrence is associated with another, that one change brings about the next, that for every effect there is a cause.

Returning to our question, it may be said that we work and work successfully on the theory that the changes which organisms undergo are natural phenomena brought about, like any others, by natural causes. The transformation of a horde of barbarians into a modern European nation; the immunity which a race acquires against specific disease; the evolution of new breeds of dogs, horses and wheat; the spreading of a race over a wide and varied area with the consequent appearance of differences which mark off the group into geographical subgroups; the gradual loss of parts of the body, so obvious in some fossil series; the metamorphosis of a part into what is virtually a new organ; the restriction of a species to a narrow area of distribution, with the final outcome, extinction; all these we are justified in regarding as natural phenomena and as phases in the wave of change that incessantly passes over living nature.

Granted the fact of change and that it is a natural phenomenon, we become interested in the analysis of its causes. And so we begin to inquire into the origin and accentuation of the small differences which mark off a race from the parent stock. Thus we pass from the wider study of evolution to the narrower and more precise study of heredity and variation. Here the experimental method is the chief one employed, although often under the guidance of comparison and statistics.

I pass over the ideas entertained as to ways in which differences are accentuated and touch, in preference, on some of the ways in which they originate. We know very well that the body of an animal, its skin, bones, muscles, etc., made up of infinite numbers of microscopic components, the cells, responds to changes in exercise, food and environment with the production of differences which are often very well marked. But we also know that the great bulk of the obvious and familiar differences so caused are not passed on to the next generation. They are not heritable. In order to be heritable, the peculiarity must be lodged, potentially, of course, in the germ cells. These are the cells, commonly ovum and sperm, which, leading a life aloof from the body cells, give rise to the new individual.

We may then ask, do all individual differences that are heritable originate from the very start in the germ cells, and, if so, owing to

what influences? or are there subtle changes of the body cells induced by habit, food and environment, which are transmitted to and lodged in some potential form, in the germ cells? This two-sided question, it is obvious, concerns mankind in a very practical way. It has been argued warmly for many years, usually under the heading of "the inheritance of acquired characters," and still today, in a more clearly circumscribed shape than formerly, makes one of the most important general problems of experimental biology.

In past years it was widely held that the transmission from body to germ was a fact, in other words, that peculiarities developing for the first time in the body, not as the result of congenital constitution, but as the result of habit or outward circumstance, were transmissible to the germ. Weismann and others have shown that much of the evidence on which this conclusion rested is weak, and the result of their criticism has been in some measure to discredit the idea. There are, nevertheless, certain experiments which, while not demonstrating transmission from body to germ, do demonstrate perhaps the more important fact that the effect on the body of outward circumstance in one generation may be in some degree repeated in the bodies of the next generation, although the conditions which first induced the change are no longer operative.

Prominent among such experiments are the classic investigations of Standfuss and Fischer on European butterflies. Both Standfuss and Fischer showed for certain species that the temperature at which the pupal stage is kept, during its so-called sleep, may be made to affect very seriously the coloration of the butterfly into which it metamorphoses. In this way by employing temperatures above the normal and temperatures below the normal, butterflies are obtained very different in appearance from the type.

Standfuss having in this way obtained strongly altered individuals, bred from them, keeping the butterflies and their offspring not at the abnormal temperature which induced the change, but at the normal temperature. The great bulk of the offspring, the second generation of butterflies, proved to adhere to the usual type of the species. Nevertheless, a few examples departed from the type and resembled in varying degrees their parents.

In a similar experiment, Fischer subjected pupæ to an intermittent cold of —8 degrees C., and in this way obtained butterflies different from the type. The offspring of these modified individuals fell into two groups, those adhering to the type and those resembling in greater or less degree the modified parents. The percentage of the latter was a considerable one.

These and numerous other experiments (such as those of Schübeler on German wheat transplanted to Norway and back again, the work of Tower on the potato beetle, that of Sumner on breeding mice at low and high temperatures, etc.) unquestionably show that the environment can exert a modifying influence on the hereditary constitution of a race, that it can originate heritable differences between organisms. They show, moreover, that it sometimes happens that a definite change is made in the body and a corresponding change in the germ cells, the change in the body of the first generation, thus showing in a measure what the heritable effect on the race will be. These important experiments mark a real advance, and it is safe to predict that they are but the precursors of many more dealing with the effect of the environment on the germ cells. At present one cannot but feel that the amount of evidence is too slim to decide the question as to whether the environment first produces an effect on the body which is then transmitted to the germ cells, or whether the environment acts directly upon the germ cells, producing in them potential changes parallel to those produced in the body.

A second way in which heritable differences between organisms originate, that is, a second way in which changes in the properties of the germ cells are induced, is through amphimixis or development from two parents, wherein two sets of hereditary tendencies are intermingled.

Adopting this general method, investigators have in recent years attacked the problems of heredity and variation from two sides. On the one hand, students of experimental embryology, cross-fertilizing the egg of one species with the sperm of another, have occupied themselves in tracing the influence of the respective parents as displayed in the growth and differentiation of the hybrid germ. Sea urchins, frogs, fish are the objects which more than others have been used

for such studies. This is too technical a field to admit of brief description. If there were time it would be easy to show that the connections between the study of embryology and heredity are numerous, close, and indeed fundamental to any real understanding of either.

The other great application of the method of cross-breeding to the study of heredity concerns itself not with the gradual individual development but with the reappearance of the characteristics of adult organisms in the offspring and later descendants. In this study a remarkable activity now reigns, dating from the year 1900, when certain principles of hereditary transmission, originally discovered by Mendel and published in 1865, but subsequently lost sight of, were rediscovered by several European botanists. These principles lie at the center of that collection of data, law and explanatory hypothesis which we designate Mendelism and which is the outcome of a vast amount of experimental breeding of animals and plants of many kinds.

The fundamental principles of Mendelism are no doubt familiar to many of you. In this study attention is concentrated not upon the influence which one parent as a whole exerts upon a descendant, but upon the transmission of particular characteristics. The characteristics to which attention is paid are those in which the two parents differ sharply. They are contrasting characters like blackness and whiteness of fur in the rabbit, tallness and dwarfness of the pea vine, roughness and smoothness of coat in the guinea pig.

The conclusion of fundamental importance is that such characters do not blend in the descendants, but are passed on from generation to generation in their original distinctness. The characters, Mendelian or unit-characters as they are called, may be obvious or latent. In the familiar case of rabbit breeding, when a black and a white rabbit are bred from, the offspring are all black, but whiteness is latent in some, for, if the black offspring are interbred, a certain proportion of white rabbits will appear among the grandchildren.

A point of importance is that the Mendelian characters of an ancestor behave in heredity independently of one another in such wise that new combinations may be made. Thus, if a dark, smooth guinea pig be bred to a white rough guinea pig, and the offspring be inter-

bred, the grandchildren will be of four kinds, with respect, that is, to the qualities darkness and whiteness, smoothness and roughness (W. E. Castle). Some will be like the grandfather and some like the grandmother. But there will be other grandchildren like neither of the grandparents. In these a grandfather feature is combined with a grandmother feature, and so we get dark rough and white smooth pigs.

Thus qualities which exist apart from one another in separate organisms may be combined in one and the same individual, and new breeds be created. In such new breeds it is apparent that new qualities are not created. What is created is a new combination. This is heritable and therefore marks off the breed from others. Hybridization here, then, originates heritable differences between organisms. It may be added that the independent behavior of Mendelian characters in heredity is not necessarily equal throughout a long series of characters. In other words, characters sometimes, perhaps always, tend to reappear in groups. This important fact has been especially brought out by recent work on the heredity of the little fruit-fly, *Drosophila* (T. H. Morgan).

In a loose and general way it has always been known that new combinations of characters occur in organisms bred from two parents. In this connection Goethe's verses have often been quoted, by Haeckel and others:

> **From father I get my height**
> **And my earnestness;**
> **From mother dear my gladness of nature**
> **And delight in romancing.**[1]

But Mendel's achievement was to discover order where no order had been recognized, to demonstrate that the combinations which are made are of a constant character and, moreover, are embodied in groups of grandchildren numerically proportionate to one another. We have seen that where, as in the case of the guinea pigs, two pairs of characters are considered, there will be four kinds of grandchildren. It may be added that in such a case the four kinds will be represented by the proportional numbers 3, 3, 9, 1. That is, for

[1] "Vom Vater hab' ich die Statur," etc.

three of one kind, there will be three of another, nine of another and one of yet another. The larger the number of contrasting points, the greater will be the number of kinds of grandchildren. Thus Correns, one of the rediscoverers of the Mendelian principles, calculates that if the first parents differ in respect to ten points there will be more than a thousand different kinds of grandchildren.

Mendel's explanation of the phenomena that now bear his name was in the shape of an hypothesis which with various alterations, some of which are important, is in general use today. He conceived of each contrasting character as potentially represented in a germ cell by a particular "something." This something we speak of as a germinal factor, a unit-factor or a gene. It is thought of as a definite entity. Many, indeed, perhaps most, look on it as a material particle. Others do not make the attempt to visualize it. When the egg and sperm fuse, corresponding germinal factors are brought together in pairs, each pair of factors representing a pair of contrasting characters, blackness and whiteness of rabbit fur, for example. Thus brought together in the fertilized egg, the two factors of a pair may each produce an effect on the body of the organism into which the egg develops. Or one factor may completely dominate the other, the organism bearing the impress of that factor alone, the other lying dormant. When, for example, in the egg of the rabbit, the factors for blackness and whiteness are brought together, the factor for blackness being dominant, the egg develops into a black rabbit. But now as the germ cells are formed which will give rise to the next generation, the factors are supposed to be sorted out among them in such wise that any one germ cell does not get both, but only one, of a pair of factors. Thus, in our example, eggs will be produced having the factor for blackness only, and others the factor for whiteness only. Similarly with the sperm cells, some will have the factor for blackness, some that for whiteness. No germ cell will have both factors. This separation of the factors with the result that the germ cells produced in an individual are unlike, is the most important feature of the Mendelian hypothesis. Working on this hypothesis, it can be calculated what will be the proportionate number of individuals embodying any particular combination of characters which, through

experiment, have been found to behave in Mendelian fashion. The hypothesis has received wide and striking confirmation in that the results of the actual breeding experiments agree closely with the calculated expectations.

Such extensive use of the unit-factor hypothesis has been made that in the graphic language of the day an organism is sometimes depicted as a bundle of separate qualities, of so-called unit-characters, each the outcome in mechanical fashion of a single discrete germinal cause, which does not vary and which is self-propagative. Viewed in this artificial light, biology assumes a rigid appearance far from its real nature, its task appearing twofold, to discover through cross breeding the elementary or unit characters of organisms and the laws governing their combination.

It should be said that such a conclusion is implied rather than positively stated in the writings I have in mind, and is expressly condemned by some prominent students of Mendelian heredity (T. H. Morgan). The facts of paleontology, anatomy and development demonstrate how artificial it is, for they show that every part and process varies among the individuals of any one time, and the *mode* or typical condition changes from age to age. Moreover, the parts of the body are so interconnected materially and their activities or functions are so interassociated, that to speak of the body as a group of units is misleading. It is to misuse the license that is only allowed in allegory, or in science for the purpose of facilitating description. A tiled floor is composed of pieces which can be taken apart and recombined. But an organism, Olivia for instance, is not a mosaic, for the items in her inventory, as "two lips indifferent red, two grey eyes with lids to them," are not separate and independent components. The essential features of an organism appear to be as closely associated, fully as inseparable, as are the corners, cleavage, color and lustre of a crystal, of calcite, for example. For given the right conditions, the germ cell or other regenerative mass will always produce them.

I hasten to remind you that "unit-character" in technical studies on Mendelian heredity has a definite meaning, referring to the class of differential features, which mark off the individuals of a race, or

of allied races, one from the other. Such would be the color of the eye, perhaps, or the fullness and curve of the lip. It is, as already said, these contrasting features in respect to which the two parents differ, which behave independently of one another and which may therefore be recombined in various ways.

The question as to the permanency of such characters in hereditary lines is interesting to all of us. There is no doubt that they are remarkably constant and persistent, but experimental breeding amply demonstrates that they are subject to the sudden changes known as mutations. It has also been demonstrated that in the course of selective breeding they undergo change (W. E. Castle). They show, then, as do the many series of intergrading organisms, that the rule of heredity over living things is not absolute. Living things, in fact, continually escape from its tyranny through modification of their germ-cell substance, modification which is brought about through interaction with the environment and through interaction with other germ-cell substances, the latter action leading not only to new combinations of the old, as in ideally strict Mendelism, but to actual change in the specific protoplasm, with the result that what are virtually new qualities emerge.

Mendelism has enormously increased the general interest in heredity, than which no subject in the whole field of science is more discussed today. In the midst of the discussions and admirable investigations dealing directly with this matter, it is well not to forget what heredity is. As Haeckel pointed out long ago, heredity is not a special organic function, but is only a name for the fact that the specific substance of the germ cell exhibits a set of properties substantially like those of the parent germ cell. In other words, heredity means that an egg behaves very much as the parent egg did, because, having essentially the same organization, it reacts to stimuli in essentially the same fashion. A sound knowledge of heredity is therefore dependent on a knowledge of the ways in which the many kinds of protoplasm respond to stimuli; in other words it is dependent on the general level of biological science.

In conclusion, let me say that the several aspects of zoölogy at which we have glanced has each an interest in itself. Otherwise

there would be no hope of advance. But they fade into one another. The data overlap and the problems merge. The geographical explorer, dealing with the distribution of animals; the classifier, discovering and arranging the diagnostic features of races and species; the descriptive anatomist skillfully tracing out details of structure in finished product and embryo; the comparative morphologist, outlining embryological sketches and life histories and applying his data to questions of evolution; the analytic embryologist, unraveling physiological factors, control of which enables him to bring into being the differences which he started out to explain; the student of hereditary transmission recording the way in which characters reappear, and his other half, the student of variation, who experimentally induces new differences—these and many others are all dealing with one and the same nature, the many-sided world of living and once living things of which we form a part. The various classes of phenomena exhibited by this world of organisms, as they are mapped out and in some degree analyzed, enter into and constitute biology. They form a vast and heterogeneous array, of which it may be said that the vastness will remain, will indeed steadily increase, but the heterogeneity should become less evident. For, as knowledge grows and hypothesis gives way to generalization, the various aspects of the living world will no doubt arrange themselves in a more and more coherent manner, that is, we shall be more and more able to assign them to empirically learned causes, to the fundamental powers of the group of protoplasms as shown in responses to stimuli.

CHAPEL HILL, N. C.

A LIST OF SYRPHIDÆ OF NORTH CAROLINA.

By C. L. Metcalf.

The following records are based primarily on the collections of the Division of Entomology of the State Department of Agriculture, extending over more than fifteen years. During this time the chief of the division, Mr. Franklin Sherman, Jr., and various assistants, have painstakingly assembled specimens and data concerning the insect fauna of the entire State. Too much credit can hardly be given to Mr. Sherman for his enthusiasm in prosecuting and encouraging, from the beginning, this important zoö-geographical work.

Two other important sources of records are the collections of Mr. C. S. Brimley, Zoölogist, chiefly from Raleigh, and those of Mr. A. H. Manee from Southern Pines. A part of the latter specimens are in the possession of Dr. R. C. Osburn, of the Connecticut College for Women, who has very kindly furnished the writer with a list of thirty species from that locality. These records are starred (*) in the following list.

During several years residence in the State, the writer gave some attention to this family, and practically all of the species have been identified or examined by him. Specimens have been examined from over fifty localities, extending from Smith Island on the extreme southeast to Jefferson on the northwest, and from Andrews on the southwest to Murfreesboro on the northeast.

On account of its range in altitude, North Carolina embraces a fauna representing four of the seven life-zones of North America, viz., the Lower Austral, the Upper Austral, the Alleghenian, and the Canadian. In order that the detailed records further on may be more significant and more readily interpreted, I indicate below the life-zone to which each of these localities is considered to belong. It must, of course, be remembered that there is no such thing as divisions between these life-zones, which grade into each other; and, consequently, the last localities listed in any zone and the first of the next may partake of the fauna of both. It is particularly impossible to list localities as belonging to the Canadian zone, since this zone in North Carolina embraces only the tops of mountains. Thus a speci-

men listed as "Grandfather Mountain" or "Highlands," unless the altitude is given, may have been taken on the highest surrounding peak or on one of the lower slopes.

LOCALITIES FROM WHICH COLLECTIONS HAVE BEEN MADE, WITH NUMBER OF SPECIES RECORDED FROM EACH, AND LIFE-ZONES INDICATED.

LOWER AUSTRAL

Smith Island	2	species
Southport	12	"
Wilmington	2	"
Lake Waccamaw	18	"
Whiteville	2	"
Burgaw	8	"
Willard	1	"
Beaufort	8	"
Lake Ellis	1	"
Havelock	1	"
Faison	4	"
Washington	1	"
Pinehurst	1	"
Southern Pines	47	"
Murfreesboro	3	"
Pendleton	6	"
*Charlotte	3	"
*Holly Springs	1	"
*Raleigh	66	"
*Garysburg	1	"
Total from Lower Austral	82	species

UPPER AUSTRAL

Norlina	1	species
Durham	2	"
Hillsboro	3	"
Greensboro	7	"
Kernersville	1	"
Ellenboro	1	"
King	1	"
Pilot Mountain	1	"
Elkin	1	"
Mount Airy	1	"
Marion	2	"
Total from Upper Austral	57	species

ALLEGHENIAN OR TRANSITION

Dendron	2	species
Black Mountain	10	"
Swannanoa	25	"
Asheville	1	"
Hendersonville	10	"
Blantyre	5	"
Lake Toxoway	4	"
Montvale	1	"
**Sunburst=Canton	28	"
**Balsam	1	"
**Highlands	6	"
Andrews	2	"
Bushnell	1	"
Whittier	1	"
Hot Springs	5	"
Cane River	1	"
Yonahlasse Road	3	"
**Blowing Rock	11	"
**Grandfather Mountain	5	"
Valle Crucis	1	"
Boone	3	"
Jefferson	5	"
Total from Alleghenian	71	species

Total from Canadian	7	species

*These localities are on the line between Lower and Upper Austral, partaking of both faunas.
**Part of the records from these localities are doubtless Canadian. However, only records which state an altitude of 5,000 feet or over are credited to the Canadian Zone.

It is of interest to compare the number of species in the different genera which have been recorded in lists from other Eastern States. Although to some extent these differences are due to the amount of attention which has been given the family by collectors, still they do indicate to some extent the richness of a given genus in these different regions. Thus there could hardly be any doubt, from the records below, that Toxomerus, Volucella, Brachypalpus, and Microdon, for example, present a richer fauna as one progresses southward; while Pipiza, Syrphus, and Tubifera, on the other hand, show a greater differentiation toward the north.

TABLE OF GENERA AND SPECIES AS RECORDED FOR CERTAIN EASTERN STATES.

Genus	Number of Species Recorded for—				
	Quebec[1]	Ohio[2]	N. J.[3]	N. C.	Fla.[4]
Paragus	1	3	3	4	1
Pipiza	3	6	4	3	2
Psilota			1	1	1
Chrysogaster	3	3	4	4	1
Chilosia	4	4	5	3	
Platychirus	2	3	4	3	
Pyrophaena	1		1		
Melanostoma	3	2	2	3	
Didea		1	1	2	
Syrphus	8	8	12	12	1
Allograpta	1	1	1	2	1
Sphaerophoria	1	2	1	1	
Toxomerus (Mesogramma)	3	3	4	5	7
Xanthogramma	1	3	4	1	1
Baccha	2	4	5	4	4
Ocyptamus		1	1	1	3
Pelecocera			1		
Sphegina	1	3	3	4	
Neoascia	1	1	2		
Brachyopa	2	1			
Rhingia	1	1	1	1	
Volucella	1	3	3	4	8
Eristalis	6	8	8	9	4
Meromacrus		1		1	2
Tubifera (Helophilus)	3	8	10	5	2
Teuchocnemis	1		2	2	
Pterallastes		1	1	1	
Mallota	2	2	2	3	1
Triodonta		1	1		
Tropidia	1	1	3	2	1

TABLE OF GENERA AND SPECIES AS RECORDED FOR CERTAIN EASTERN STATES.—CONTINUED.

Genus	Number of Species Recorded for—				
	Quebec[1]	Ohio[2]	N. J.[3]	N. C.	Fla.[4]
Myiolepta		3	1	3	
Chalcomyia		1		1	
Penthesilea (Criorrhina and Somula)	1	2	2	2	
Merapioidus		1		1	
Cynorrhina	1	3	3	4	
Brachypalpus	1	2	3	5	
Zelima (Xylota)	5	8	10	11	2
Syritta	1	1	1	1	
Ferdinandea (Chrysochlamys)		1	1	1	
Cinxia (Sericomyia)	2	2	1	2	
Milesia		1	1	1	1
Spilomyia	3	4	3	3	1
Temnostoma	2	4	4	4	
Chrysotoxum	1	1	3	2	
Sphecomyia	1	1	1	1	
Callicera			1	1	
Myxogaster			1		
Microdon	3	2	5	4	9
Cericides (Ceria)	1	2	1		3
Total number of genera	35	43	45	42	21
Total number of species	74	114	132	128	56

[1]Chagnon, G., Etudes Preliminaires sur les Syrphides de la Province de Quebec, Extrait du "Naturaliste Canadien," Quebec, 1901.
[2]Metcalf, C. L., The Syrphidæ of Ohio, Ohio Biol. Survey Bul., Vol. I, No. 1 (Ohio State Univ. Bul., Vol. XVII, No. 31), 1913.
[3]Johnson, C. W., Report on the insects of New Jersey, Diptera from Annual Rept. N. J. State Mus. (J. B. Smith), 1909.
[4]Johnson, C. W., Insects of Florida, Diptera Bul. Amer. Mus. Nat. Hist., Vol. XXXII, Art. III, 1913.

The following persons have contributed to our records on five or more species, and are referred to by initials in the list below:

Franklin Sherman, Jr., State Entomologist..... 63 species.
C. S. Brimley, Zoölogist, Raleigh..... ..... 59 species.
A. H. Manee, Southern Pines..... 46 species.
Z. P. Metcalf, Entomologist, Agricultural Experiment Station ..... 16 species.
R. S. Woglum, formerly Assistant State Entomologist. 13 species.
Mrs. A. T. Slosson, New York City..... 9 species.
C. W. Johnson, Curator, Boston Society of Natural History ..... 7 species.
C. L. Metcalf, formerly Assistant State Entomologist. 66 species.

Following the custom of previous lists from the State, each month has been divided into three parts; the first to the tenth being designated as early (E.), the eleventh to the twentieth as mid (M.), and the twenty-first to the end of the month as late (L.).

Detailed records are given in each case; and these, together with the table of localities by life-zones given above, should enable any one to decide as to the probable occurrence of a species in any part of the State.

In the matter of nomenclature and synonomy, the writer has followed, for the most part, the catalogue of the Diptera of the world by Dr. C. Kertesz.*

ANNOTATED LIST OF SPECIES.

Paragus angustifrons Loew.

Lake Waccamaw, E. Apr. (C. L. M.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch. (A. H. M.); *Pendleton*, E. June (C. W. J.); *Raleigh*, E. Jly. (C. L. M.), E. Aug. (F. S.).

Paragus bicolor Fabr.

Southern Pines, M. Mch. (C. L. M.); *Grandfather Mountain*, M. Sep., 5,000 ft. (Z. P. M.).

Paragus dimidiatus Loew.

Blowing Rock, E. Sep. (C. L. M.).

Paragus tibialis Fall.

Southern Pines, M. Mch. (C. L. M.), M. June*; *Raleigh*, E. Jly., M. Jly., E. Aug., M. Aug. (C. L. M.).

Pipiza pisticoides Willist.

Swannanoa, M. Apr., ♂ about apple blossoms (C. L. M.).

Pipiza pulchella Willist.

Southern Pines, L. Oct. (A. H. M.).

Pipiza radicum Walsh and Riley.

Swannanoa, M. Apr., ♂ (C. L. M.)

Psilota buccata Macq.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch., E. Apr., M. Apr. (A. H. M.); *Raleigh*, L. Mch., M. Apr. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.); common.

*Catalogus Dipterorum hucusque Descriptorum, Vol. VII, C. Kertesz, Museum Nationale Hungaricum, Budapest, 1910.

CHRYSOGASTER NIGRIPES Loew.
Southport, E. Apr. (C. L. M.); *Charlotte*, E. June (F. S.); *Raleigh*, M. Apr. (C. S. B. and C. L. M.); *Hendersonville*, June (F. S.).

CHRYSOGASTER NITIDA Wied.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, E. Apr.*; *Pendleton*, E. June (C. W. J.); *Raleigh*, E. Mch., M. Apr. (C. L. M.), E. June (R. S. W.), E. Jly., M. Jly., L. Jly., E. Aug. and M. Aug. (C. L. M.); *Hillsboro*, M. June (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Hot Springs*, May or June (A. T. S.); *Blowing Rock*, Sep. (F. S.). Evidently distributed throughout the state and occurring throughout the summer.

CHRYSOGASTER PICTIPENNIS Loew.
Southport, E. Apr. (C. L. M.); *Raleigh*, E. Aug., abundant, (C. L. M.).

CHRYSOGASTER PULCHELLA Willist.
Southern Pines, L. Mch.*, E. Apr. (A. H. M.).

CHILOSIA CAPILLATA Loew?
A male, *Southern Pines*, E. Apr. (A. H. M.), is doubtfully referred here. It differs from the description in the color of the pile on the frons and in lacking the groove on the scutellum.

CHILOSIA PALLIPES Loew.
Sunburst, (=*Canton*), June (F. S.).

CHILOSIA WILLISTONI Snow.
Raleigh, M. Nov. (C. L. M.)

PLATYCHIRUS CHAETOPODUS Willist.
Blantyre, E. May (F. S.).

PLATYCHIRUS HYPERBOREUS Staeger.
Raleigh, L. Mch. (C. L. M.); *Jefferson*, M. Sep. (C. L. M.).

PLATYCHIRUS QUADRATUS Say.
Raleigh, L. Mch. (F. S. and C. L. M.).

MELANOSTOMA ANGUSTATUM Willist.
Sunburst (=*Canton*), L. May (C. S. B.).

MELANOSTOMA MELLINUM Linné.
Raleigh, L. Mch. (C. S. B.), M. Apr. (C. S. B. and C. L. M.); *Hendersonville*, June, (F. S.); *Sunburst* (=*Canton*), L. May, (C. S. B.); *Jefferson*, M. Aug. (F. S.).

MELANOSTOMA OBSCURUM Say.
Southern Pines, E. Nov.*; *Raleigh*, E. Mch. (C. S. B. and C. L. M.), L. Mch., M. Apr. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.); *Sunburst* (=*Canton*), L. May (C. S. B.).

Didea fasciata Macq. *var.* fuscipes Loew.
Southern Pines, L. Mch.*; *Raleigh*, L. Mch. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.); *Sunburst* (=*Canton*), L. May (F. S.).

Didea laxa O. S.
Sunburst (=*Canton*), L. May (C. S. B., F. S. and S. C. Clapp).

Syrphus amalopis O. S.
Black Mountain, L. May (F. S.).

Syrphus americanus Wied.
Southport, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Beaufort*, M. May (R. S. W.), E. June (F. S.); *Southern Pines*, M. Mch. (C. L. M.), M. Nov. (A. H. M.); *Raleigh*, L. Jan., on wing, (C. L. M.); Feb., L. Mch. (C. S. B.), E. Mch., common, (C. L. M.), L. Mch., E. Apr. (Z. P. M. and C. L. M.), L. Apr. (C. L. M.), L. May (F. S.), L. Aug. (Z. P. M.), L. Oct. (C. L. M.), L. Nov. (C. S. B.); *Durham*, L. May (C. S. B.); *Swannanoa*, M. Apr., common, (C. L. M.); *Sunburst* (=*Canton*), L. May (C. S. B.); *Bushnell*, E. Sep. (G. M. B.); *Blowing Rock*, Sep. (F. S. and R. W. Leiby). Common throughout the state except for an apparent break between generations in summer.

Syrphus arcuatus Fall.
Raleigh, L. Mch., common about blossoming willow (C. L. M.); *Black Mountain*, L. May (F. S.).

Syrphus fisherii Walton.
Blowing Rock, Sep. (F. S.). *Male.* Oral margin and cheeks yellow, frontal triangle in the middle brownish, shining, along the eyes yellowish pollinose. Scutellum dark brown, yellow along the margin. First abdominal segment shining black, the black of the second segment opaque; yellow band about half the length of segment situated a little in front of the middle, interrupted by about one-fourth the width of the segment. Posterior margins of fourth and fifth segments narrowly yellow.

Syrphus species No. 1.
Sunburst (=*Canton*), L. May (C. S. B.).

Syrphus grossulariæ Meig. (*S. lesueurii* Macq.)
Raleigh, L. Mch. (C. S. B.), L. May (F. S.), M. Nov. (C. S. B.); *Blowing Rock*, L. Aug., Sep. (F. S.)

Syrphus perplexus Osburn
Raleigh, L. Mch., about blossoming willow (C. L. M.).

Syrphus protritus O. S.
Raleigh, L. Mch. (C. L. M.).

SYRPHUS RIBESII Linné.

Southport, E. Apr. (C. L. M.); *Southern Pines*, L. Mch.*; *Raleigh*, L. Mch. (C. S. B. and C. L. M.), Apr., M. Oct., M. Nov. (C. S. B.); *Greensboro*, L. Mch. (Z. P. M.); *Blowing Rock*, Sep. (F. S.). Reared from larva taken among *Schizoneura tessellata*, *Valle Crucis*, M. Sep. (C. L. M.).

SYRPHUS TORVUS O. S.

Southern Pines, M. Mch. (F. S. and C. L. M.); *Raleigh*, M. Mch. (C. S. B.); L. Mch. (C. L. M.), L. Apr., L. Oct., L. Dec. (C. S. B.); *Greensboro*, L. Mch., common (F. S.); *Ellenboro*, M. Mch. (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Sunburst* (=*Canton*), L. May (C. S. B.); *Grandfather Mountain*, 5000 ft., L. July (G. M. B.), M. Sep. (Z. P. M.); *Jefferson*, M. Sep. (C. L. M.).

SYRPHUS XANTHOSTOMUS Willist.

Southport, E. Apr. (C. L. M.); *Raleigh*, L. Mch. (C. L. M.), L. May (F. S.), E. June (C. S. B.); *Black Mountain*, L. May (F. S.).

SYRPHUS species No. 2.

Near *S. americanus* but has cheeks yellow and lacks the black facial stripe, *Swannanoa*, M. Apr. (C. L. M.).

ALLOGRAPTA FRACTA O. S.

Blowing Rock, Sep. (F. S.).

ALLOGRAPTA OBLIQUA Say.

Beaufort, E. May (R. S. W.), E. June (F. S.); *Southern Pines*, M. June*, M. Aug.*, L. Oct. (A. H. M.); *Murfreesboro*, E. June (C. W. J.); *Raleigh*, May (C. S. B.), M. June (R. S. W. and C. L. M.), E. July (C. L. M.), L. July (F. S.), L. Sep., Oct., M. Nov. (C. S. B.), E. Dec. (F. S.); *Norlina*, M. July (S W. Foster); *Dendron*, E. Aug. (J. P. Spoon); *Swannanoa*, M. Apr. (C. L. M.). Generally distributed throughout the state, common but seldom abundant.

SPHAEROPHORIA CYLINDRICA Say.

Beaufort, E. June (F. S.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, M. Mch. (C. L. M.), E. June*. E. Nov., M. Nov. (A. H. M.); *Raleigh*, E. Mch. (C. S. B.), L. Mch., L. Apr. (C. L. M.), June (C. S. B.), E. July (C. L. M.), L. July, M. Oct. (C. S. B.), L. Oct. (F. S.); *Charlotte*, E. June (F. S.); *King*, E. Oct. (S. C. Clapp); *Black Mountain*, L. May (F. S.); *Swannanoa*, M. Apr., M. May (C. L. M.); *Hendersonville*, June (F. S.); *Blantyre*, E. May (F. S.); *Sunburst* (=*Canton*), L. May (C. S. B.); *Yonahlosse Road*, M. Sep. (C. L. M.); *Blowing Rock*, Sep. (F. S.); *Boone*, M. Sep. (C. L. M.).

TOXOMERUS (*Mesogramma*) BOSCII Macq.

Lake Waccamaw, E. Apr. (C. L. M.); *Pendleton*, E. June (C. W. J.);

Raleigh, L. Jly. (Z. P. M.); *Sunburst* (=*Canton*), L. May (C. S. B.); *Grandfather Mountain*, M. Sep., 5000 ft. (Z. P. M.).

Toxomerus (*Mesogramma*) duplicatus Wied.
Raleigh, L. June (Z. P. M.).

Toxomerus (*Mesogramma*) geminatus Say.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Murfreesboro*, E. June (C. W. J.); *Pendleton*, E. June (C. W. J.); *Southern Pines*, E. Nov. (A. H. M.); *Raleigh*, E. Mch., M. Mch., L. Mch. (C. L. M.), M. Apr. (C. S. B.), L. June (F. S.), M. June (C. L. M.); M. Sep. (C. S. B. and C. L. M.), M. Nov. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.); *Black Mountain*, L. May (F. S.); *Yonahlosse Road*, M. Sep. (C. L. M.); *Blowing Rock*, Sep. (F. S.); *Jefferson*, M. Sep. (C. L. M.). Throughout the state, common spring and fall with an evident gap in midsummer.

Toxomerus (*Mesogramma*) marginatus Say.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Beaufort*, E. June (F. S.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch. (A. H. M.), E. Aug.,* E. Nov.,* M. Nov.,* L. Nov. (A. H. M.); *Raleigh*, L. Mch., M. Apr., E. May, E. June, M. June, E. July, M. July, L. July, E. Aug., M. Aug., L. Aug., E. Sep., M. Sep., E. Oct., E. Nov., M. Nov., L. Nov. (F. S., C. S. B., Z. P. M., C. L. M.); *Swannanoa*, M. Apr., variety, (C. L. M.), M. July, (Z. P. M.); *Hendersonville*, June (F. S.); *Balsam*, 3,500 ft., M. Sep. (Z. P. M.); *Yonahlosse Road*, M. Sep. (C. L. M.); *Blowing Rock*, E. Sep. (F. S. and R. W. Leiby); *Grandfather Mountain*, E. Sep., M. Sep., 5,000 ft. (Z. P. M.); *Jefferson*, M. Sep. (F. S. and C. L. M.). Uniformly distributed throughout the state, often very abundant.

Toxomerus (*Mesogramma*) parvulus Loew?
I refer here with some question a male, *Grandfather Mountain*, 11 Sep., '08, 5000 ft. (Z. P. M.).

This name has been considered synonymous with *T. boscii* Macq. (Hunter). The above specimen differs especially from those referred to *boscii* in lacking the conspicuous, lateral thoracic stripes, the side margins being only obscurely yellowish for a short distance above the base of the wings. Three slender, cinereous shining stripes on mesonotum. First abdominal segment more narrowly yellow at base than in *boscii* and the yellow band on second segment broader, straight, not interrupted. Yellowish fasciæ on third and fourth segments broader, the posterior processes much produced, until on the fourth segment the fascia is broken up into five longitudinal stripes by the black interruptions. Hind tibiæ mostly black, the tarsi infuscated.

Toxomerus (*Mesogramma*) politus Say.
Beaufort, M. June (F. S.); *Southern Pines*, M. Aug.*, L. Aug. (A. H. M.);

Raleigh, M. Apr. (Z. P. M.), M. June (C. S. B.), E. July (C. L. M.), M. Aug. (Z. P. M. and C. O. Houghton), Aug. (C. S. B.), L. Sep. (C. S. B. and F. S.), E. Oct. (C. L. M.), L. Oct. (C. S. B. and C. L. M.), M. Nov. (C. L. M.); *Greensboro*, L. Aug. (F. S.); *Dendron*, E. Aug. (J. P. Spoon); *Swannanoa*, M. Apr. (C. L. M.); *Asheville*, M. Aug. (G. M. B.); *Blantyre*, L. Sep. (R. S. W.); *Sunburst* (=*Canton*), June (F. S.); *Highlands*, Sep. (F. S.); *Andrews*, M. Aug. (F. S.); *Blowing Rock*, E. Sep. (F. S. and R. W. Leiby). This, the corn-feeding Syrphid-fly, is thus seen to be distributed over the state with the possible exception of the extreme southeast. The larvæ and pupæ have been found in great numbers on corn at Raleigh (Z. P. M. and C. L. M.); but their feeding did no apparent damage.

XANTHOGRAMMA EMARGINATUM Say.
Burgaw, E. Apr. (C. L. M.); *Highlands*, Sep. (R. S. W.); *Blowing Rock*, Sep. (F. S.).

BACCHA CLAVATA Fabr.
Raleigh, M. and L. Sep., 1♂, 2♀, (C. S. B.).

BACCHA COSTATA Say.
Raleigh, M. Sep. (C. S. B.).

BACCHA LUGENS Loew.
Raleigh, E. Sep. (C. S. B.).

BACCHA TARCHETIUS Walk.
Whiteville, July (R. S. W.); *Willard*, July (Z. P. M.); *Raleigh*, E. July (F. S.), M. July (C. S. B.); *Albemarle*, E. Aug. (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Hendersonville*, June (F. S.); *Sunburst*, L. May (C. S. B.); *Hot Springs*, May or June (A. T. S.).

OCYPTAMUS (*Baccha*) FUSCIPENNIS Say. [nec *Baccha fascipennis* Wied. (*B. aurinota* Walk)].
Beaufort, M. June (F. S.); *Whiteville*, July (R. S. W.); *Washington*, M. July (F. S.); *Southern Pines*, M. Nov.*; *Raleigh*, L. May (C. S. B.), E. July (F. S.), M. July (C. S. B.), L. July (C. L. M.), E. Aug. (C. L. M.), M. Aug. (C. O. Houghton), E. Sep. (F. S. and C. S. B.), L. Sep., L. Oct. (C. S. B.); *Black Mountain*, L. May (F. S.); *Sunburst*, (=*Canton*), L. May (C. S. B.); *Hot Springs*, May or June (A. T. S.); *Blowing Rock*, M. Sep. (F. S. and C. L. M.).

SPHEGINA INFUSCATA Loew.
Sunburst (=*Canton*), L. May (C. S. B.).

SPHEGINA KEENIANA Willist.
Sunburst (=*Canton*), L. May (F. S. and C. S. B.).

Sphegina lobata Loew.
Sunburst (=*Canton*), L. May (C. S. B.).

Sphegina rufiventris Loew?
A number of light-colored specimens, *Swannanoa*, M. Apr. (C. L. M.), may be teneral individuals of this species.

Rhingia nasica Say.
Raleigh, L. Apr. (C. L. M.), E. Nov. (C. S. B.); *Black Mountain*, L. May (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Lake Toxoway*, May or June (A. T. S.); *Homestead*, M. Aug. (S. W. Foster); *Sunburst*, (=*Canton*), L. May (C. S. B. and F. S.), June (F. S.); *Highlands*, Sep. (F. S.); *Blowing Rock*, Sep. (F. S.); *Grandfather Mountain*, 4,000 to 5,000 ft. E. Sep. (F. S.); *Jefferson*, M. Sep. (F. S.).

Volucella fasciata Macq.
Southern Pines, L. June*, E. Sep.*. A male, *Southern Pines*, M. Mch. (C. L. M.), has the antennæ entirely brownish; the yellow markings on thorax much less distinct; and the abdomen with only two yellow bands, the one on the third segment much attenuated toward the middle, almost disappearing, and both fasciæ widely separated from the margin.

Volucella pallens Wied. (*V. sexpunctata* Loew).
Raleigh, L. July (C. S. B.), M. Aug. (C. L. M.).

Volucella vesiculosa Fabr.
Raleigh, M. May (C. S. B.), L. May (F. S.). In sugar trap, M. June, L. June, M. July, L. July (C. S. B.); *Blantyre*, E. May (F. S.).

Eristalis aenea Scop.
Charlotte, E. June (F. S.); *Raleigh*, L. Mch. (F. S. and C. S. B.), E. May (C. S. B.), June, July (C. S. B.), M. Aug. (C. L. M.), E. Oct. (F. S.), M. Oct., Nov. (C. S. B.); *Hillsboro*, M. June (F. S.); *Greensboro*, L. Mch. (Z. P. M.); not common.

Eristalis albifrons Wied.
Beaufort, E. July (F. S.).

Eristalis arbustorum Linné.
Raleigh, L. Mch., M. Apr. (C. L. M.), May (C. S. B.), E. Jly. (C. S. B. and C. L. M.), E. Aug. (F. S. and C. S. B.), M. Aug. (C. L. M.); *Durham*, L. May (C. S. B.); *Blowing Rock*, Sep. (F. S.).

Eristalis dimidiata Wied.
Smith Island, Oct. (F. S.); *Southport*, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Faison*, M. Oct. (F. S.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch., L. Apr., E. Sep.,

L. Sep.*, E. Nov.*, M. Nov.* (A. H. M.); *Raleigh*, E. Mch. (C. L. M.), Mch. (C. S. B.), L. Mch., E. Apr. (F. S.), Apr., E. May (C. S. B.), L. Sep. (F. S.), E. Oct. (C. S. B.), E. Nov. (F. S.), M. Nov. (C. S. B.); *Greensboro*, L. Mch. (F. S.).

ERISTALIS FLAVIPES Walk.

Raleigh, L. Oct. (F. S.).

ERISTALIS SAXORUM Wied.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr., abundant (C. L. M.); *Lake Ellis* (*Havelock*), E. May (C. S. B.); *Raleigh*, M. June (C. S. B.).

ERISTALIS TENAX Linné.

Lake Waccamaw, E. Apr. (C. L. M.); *Beaufort*, E. June (F. S.); *Southern Pines*, M. Mch. (C. L. M.), E. June (R. S. W.), E. Nov.*, M. Nov.* (A. H. M.); *Holly Springs*, in collection R. F. Collins, (F. S.); *Raleigh*, L. Jan., on wing (C. L. M.), E. Mch. to L. July and E. Oct. to L. Dec. (F. S., C. S. B., C. L. M.); *Hillsboro*, M. June (F. S.); *Greensboro*, M. Mch. (S. C. Clapp), L. Mch. (F. S.); *Kernersville*, M. June (F. S.); *Pilot Mountain*, M. Nov. (G. M. Bently); *Marion*, M. July (F. S.); *Black Mountain*, L. May (F. S.); *Hendersonville*, June (F. S.); *Sunburst* (=*Canton*), L. May (F. S. and S. C. Clapp); *Blowing Rock*, L. June (F. S.), E. Sep., common, M. Sep. (F. S.). Everywhere abundant spring and fall. There are no records of its occurrence for August or September, which probably indicates two distinct generations a year.

ERISTALIS TRANSVERSA Wied.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Faison*, M. Oct. (F. S.); Murfreesboro, E. June (C. W. J.); *Pendleton*, E. June (C. W. J.); *Southern Pines*, L. Mch.*, E. Apr. (C. L. M.), E. Nov.*, (A. H. M.); *Elkin*, M. June (F. S.); *Raleigh*, L. Mch. (C. S. B.), E. Apr. (F. S.), M. Apr., L. Apr., E. May (C. L. M.), M. May (Z. P. M.), M. June (R. S. W.), E. Jly. (C. L. M.), L. Jly. (C. S. B.), E. Aug., L. Aug. (C. L. M.), M. Sep. to L. Dec. (C. S. B.); *Hendersonville*, June (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Highlands*, Sep. (R. S. W.); *Whittier*, M. Sep. (F. S.); *Cane River*, Sep. (F. S.); *Blowing Rock*, E. Sep., common (F. S.); *Boone*, M. Sep. (C. L. M.). Common throughout the state spring and fall, rare or wanting August and September.

ERISTALIS VINETORUM Fabr.

Wilmington, M. Nov. (F. S.) ; *Faison*, M. Oct. (F. S.); *Southern Pines*, Jly. (A. H. M.), L. Aug.*, E. Sep.*; *Raleigh*, L. Mch., M. June, L. Jly., L. Sep., Oct. (C. S. B.).

MEROMACRUS ACUTUS Fabr. (*Pteroptila crucigera* Wied.).

Raleigh, L. July (Z. P. M. and C. S. B.), E. Aug., L. Sep. (C. S. B.); *Blantyre*, M. June (R. W. Collett).

Tubifera (*Helophilus*) chrysostoma Wied.
Raleigh, E. May, M. June, M. July (C. L. M.), L. July (C. S. B. and C. L. M.), E. Aug., M. Aug. (C. L. M.), L. Sep. (F. S.).

Tubifera (*Helophilus*) flavifacies Bigot?
Raleigh, M. July (C. S. B.). This specimen differs from the specimen referred to T. integra (q. v.) in having the first yellow, abdominal band not interrupted in the middle and the fifth segment unmarked with black. The hind tarsi are infuscated but not blackish. The hind femora with less black, the abdomen as a whole more yellowish.

Tubifera (*Helophilus*) integra Loew.
Raleigh, E. Aug., on mint (C. S. B.).

Tubifera (*Helophilus*) laeta Loew.
Southern Pines, L. June*.

Tubifera (*Helophilus*) similis Macq.
Smith Island, M. Oct. (F. S.); *Southport*, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Faison*, M. Oct. (F. S.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch.*, E. Apr., M. Apr. (A. H. M.); *Raleigh*, L. Mch. (C. S. B.), M. Apr. (C. S. B. and C. L. M.), E. Oct., L. Oct., M. Nov. (C. S. B.).

Teuchocnemis bacuntius Walk.
Southport, E. Apr., 2♀, 1♂, (C. L. M.); *Lake Waccamaw*, E. Apr., ♀, (C. L. M.); *Southern Pines*, E. Apr. (A. H. M.).

Teuchocnemis liturata Loew.
Raleigh, M. Apr. (C. S. B.).

Pterallastes thoracicus Loew.
Hendersonville, June (F. S.); *Blowing Rock*, E. Sep., 3500 ft. (F. S.).

Mallota cimbiciformis Fall.
Southern Pines, L. Mch.* (A. H. M.).

Mallota posticata Fabr.
Raleigh, L. Apr. (F. S.), L. May, M. June (C. S. B.), L. Aug. (F. S.), L. Oct. (F. S.); *Black Mountain*, L. May (F. S.); *Sunburst* (=*Canton*), June (F. S.).

Mallota sp.
Southport, E. Apr. (C. L. M.). ♀, nearest M. cimbiciformis but quite distinct.

Tropidia albistylum Macq.
Raleigh, M. Apr., ♂, (C. L. M.); *Sunburst* (=*Canton*), June, ♀, (F. S.); *Hot Springs*, May or June (A. T. S.).

TROPIDIA QUADRATA Say.
Raleigh, May to Sep. (C. S. B.), M. Aug. (C. L. M.).

MYIOLEPTA NIGRA Loew.
N. C. (Williston, **p. 129).

MYIOLEPTA STRIGILATA Loew.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Southern Pines*, E. Apr. (A. H. M.); *Raleigh*, L. Mch., L. Apr., M. Apr., (C. L. M.). No evident luteous spot on side of face.

MYIOLEPTA VARIPES Loew.
Raleigh, May (C. S. B.).

CHALCOMYIA AEREA Loew.
Southern Pines, L. Mch.* (A. H. M.).

PENTHESILEA (*Somula*) DECORA Macq.
Raleigh, L. Apr., M. May (C. S. B.); *Mount Airy*, June (Z. P. M.); *Swannanoa*, M. Apr. (C. L. M.); *Lake Toxoway*, May or June (A. T. S.).

PENTHESILEA (*Criorrhina*) VERBOSA Walk.
Montvale, L. Apr. (F. S.).

MERAPIOIDUS VILLOSUS Bigot.
Greensboro, L. Mch. (F. S.).

CYNORRHINA NOTATA Wied.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, L. Mch.*, E. Apr. (A. H. M.); *Lake Toxoway*, May or June (A. T. S.).
In some female specimens, the four anterior femora are entirely yellowish. Front black above, cheeks broadly entirely black, face yellowish.

CYNORRHINA PICTIPES Bigot.
Southport, E. Apr., abundant, (C. L. M.); *Burgaw*, E. Apr., abundant, (C. L. M.); *Southern Pines*, E. Apr.* (A. H. M.); *Raleigh*, M. Apr. (F. S. and C. S. B.); *Swannanoa*, M. Apr. (C. L. M.).

CYNORRHINA UMBRATILIS Willist.
Southern Pines, E. Apr. (A. H. M.); *Raleigh*, L. Apr. (C. L. M.); *Swannanoa*, M. Apr., about Juneberry (C. L. M.).

CYNORRHINA SP.
♂ *Southern Pines*, E. Apr. (A. H. M.). Near C. NOTATA but differs in abdominal markings, in having a black facial stripe and black on frontal triangle above.

**Williston, Samuel W., Synopsis North American Syrphidæ, Bul. U. S. Natl. Museum, No. 31, Wash., 1886.

Brachypalpus amithaon Walk.
N. C., (Williston, *loc. cit.*, p. 297).

Brachypalpus frontosus Loew.
Southern Pines, M. Mch.*; *Raleigh*, Mch. (C. S. B.), L. Mch. (C. L. M.).

Brachypalpus pulcher Willist.
Southern Pines, 24 Feb. (A. H. M.).

Brachypalpus rileyi Willist.
N. C. (Williston, *loc. cit.*, p. 222).

Brachypalpus sorosis Willist.
Southern Pines, E. Mch., L. Mch.*, E. Apr., M. Apr. (A. H. M.).

♀. Front black, on the vertex shining, metallic bronze; below opaque; covered with whitish pubescence, which on the sides next the eyes entirely obscures the black ground color; pile yellow. Entire antennal prominence and face yellow, shining in the middle, whitish pubescent on the sides. Cheeks shining black. Thorax similar to the male, the notum a little less brilliantly bronze. Abdomen as in the male. Legs and antennæ entirely yellowish, only the tips of the tarsi infuscated; although in some of the males the femora are black, except at base and apex, and the antennæ decidedly infuscated.

Zelima (*Xylota*) analis Willist.
Lake Waccamaw, E. Apr. (C. L. M.).

Zelima (*Xylota*) angustiventris Loew.
Southern Pines, M. June*; *Lake Toxoway*, May or June (A. T. S.); *Blowing Rock*, 3500 ft., E. Sep. (F. S.).

Zelima (*Xylota*) anthreas Walk.
Lake Waccamaw, E. Apr. (C. L. M.).

Zelima (*Xylota*) bicolor Loew.
Hendersonville, June (F. S.).

Zelima (*Xylota*) chalybea Wied.
Raleigh, E. June (F. S.), M. June (C. S. B.).

Zelima (*Xylota*) ejuncida Say.
Southern Pines, E. Apr. (A. H. M.); *Raleigh*, E. Sep. (C. L. M.); *Sunburst* (=*Canton*), L. May (C. S. B.).

Zelima (*Xylota*) elongata Willist.
Sunburst (=*Canton*), June (F. S.); *Blowing Rock*, 4,000 to 4,500 ft., June 20, 1904 (F. S.).

ZELIMA (*Xylota*) FRAUDULOSA Loew.

Lake Waccamaw, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Pendleton*, E. June (C. W. J.); *Raleigh*, L. Apr. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.). A ♀, *Raleigh*, E. June (C. S. B.), has front and middle legs and basal half of hind femora yellow. It may be distinct.

ZELIMA (*Xylota*) MARGINALIS Willist.

Sunburst (=*Canton*), L. May (F. S.).

ZELIMA (*Xylota*) PIGRA Fabr.

Lake Waccamaw, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch.*, E. Apr., M. Aug.* (A. H. M.); *Pinehurst*, M. Oct. (F. S.); *Raleigh*, Apr., L. June, L. July, Sep., Oct. (C. S. B.); *Garysburg*, E. Apr. (F. S.).

This species was reared in large numbers from larvæ collected by Professor Z. P. Metcalf at Raleigh. I quote from his letter as follows: "The Syrphidæ were collected under the bark of two pine logs about 2 feet in diameter. These logs had evidently been cut during the preceding summer and the inner bark was badly decayed and had an abundant growth of a slimy fungus of some kind. Both logs were on a hillside and the lower ends of the logs had the most larvæ—perhaps due to the fact that water had run down them so that the lower end was the dampest part. The specimens were collected March 13; and at that time about two-thirds were in the puparium. After being brought back to the laboratory more of them pupated, but these were not separated from the general lot. The larvæ seemed to feed on the decaying inner bark, so far as I could judge." The adults emerged, in the laboratory, during the latter part of March and early April. The species has previously been reared by Messrs. C. W. Johnson and V. A. E. Daecke.

ZELIMA (*Xylota*) VECORS O. S.

Black Mountain, L. May (F. S.)

ZELIMA (*Xylota*) SP.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Southern Pines*, L. Mch. (A. H. M.).

SYRITTA PIPIENS Linné.

Southern Pines, L. Mch., L. Aug.*, E. Sep.*, E. Nov., M. Nov.* (A. H. M.); *Raleigh*, M. Apr., L. Apr. (C. L. M.), E. May (C. S. B.), L. June (Z. P. M.), E. July, M. July (C. L. M.), L. July (C. S. B.), M. Aug. (C. L. M.), L. Sep., E. Oct. (C. S. B.), M. Nov. (F. S.); *Blowing Rock*, M. Sep. (F. S. and C. L. M.); *Boone*, M. Sep. (C. L. M.); *Jefferson*, M. Aug. (F. S.), M. Sep. (C. L. M.).

FERDINANDEA (*Chrysochlamys*) DIVES O. S.

Southern Pines, L. Mch. (A. H. M.); *Raleigh*, L. Oct., ♀ in moth trap (C. S. B.); *Swannanoa*, M. Apr., 2 ♀ about Juneberry (C. L. M.).

Cinxia (*Sericomyia*) chrysotoxoides Macq.
Highlands, Sep. (R. S. W.); *Grandfather Mountain*, E. Sep., 4000 ft. (F. S.).

Cinxia (*Sericomyia*) sp.
Raleigh, L. Mch. (F. S.), M. Apr. (C. L. M.).

Milesia virginiensis Drury (*M. ornata* Fabr.).
Havelock, L. May (F. S.); *Southern Pines*, M. May, L. May, E. June, M. June (A. H. M.); *Raleigh*, E. June (F. S.), June (C. S. B.), E. July (C. L. M.), July, Aug. (C. S. B.), M. Aug. (C. L. M.), Oct., E. Nov. (C. S. B.); *Marion*, M. July (F. S.); *Hot Springs*, May or June (A. T. S.); *Blowing Rock*, L. June (F. S.). Not uncommon.

Spilomyia fusca Loew.
Highlands, Sep. (R. S. W.); *Blowing Rock*, E. Sep., 3,500 ft. (F. S.).

Spilomyia hamifera Loew.
Southern Pines (A. H. M.); *Hendersonville*, June (F. S.).

Spilomyia longicornis Loew.
Southern Pines, E. Oct. (A. H. M.); *Raleigh*, M. Sep. (C. S. B.), L. Sep. (F. S.), Oct. (C. S. B.).

Temnostoma alternans Loew.
Sunburst (=*Canton*), L. May (C. S. B.).

Temnostoma bombylans Fabr.
Sunburst (=*Canton*), L. May (C. S. B.); *Andrews*, M. May (F. S.).

Temnostoma pictulum Willist.
Raleigh, M. Apr. (C. S. B.).

Temnostoma trifasciatum Roberts.
Sunburst (=*Canton*), June (F. S.).

Chrysotoxum laterale Loew.
Raleigh, L. Mch., ♀ on sassafras flowers (C. S. B.); *Swannanoa*, M. Apr. (C. L. M.).

Chrysotoxum pubescens Loew.
Southern Pines, E. June *; *Raleigh*, L. Mch. (C. S. B.).

Sphecomyia vittata Wied.
Raleigh, L. Mch. (C. L. M.).

Callicera johnsoni Hunter.
Swannanoa, M. Apr., ♀ about apple blossoms (C. L. M.). This speci-

men compared with the type in the Boston Society of Natural History agrees with it almost exactly, particularly in the color of the pile which is gray throughout.

CALLICERA JOHNSONI Hunter *var.* AURIPILA n. var.

In contrast with the above typical specimen, are about forty specimens of this rare genus, taken by the writer at *Southport*, 6 and 7 April, 1914, (cotypes) about blossoming apple and pear. These specimens, together with one from *Southern Pines*, 17 April (A. H. M.), are all very similar, except for a considerable variation in size, and all strikingly different from the typical *johnsoni* in having the pile throughout of a beautiful, deep golden color. These specimens constitute a distinct new variety.

MICRODON FUSCIPENNIS Macq.

Wilmington, Sep. (R. S. W.); *Swannanoa*, E. July (C. L. M.); *Sunburst* (=*Canton*), June (F. S.).

MICRODON LIMBUS Willist.

Southern Pines, (A. H. M.).

MICRODON PACHYSTYLUM Willist.

Southern Pines, Sep. (R. S. W.), L. Sep.*; *Raleigh*, M. June (C. S. B.), E. July (Z. P. M.), L. July (C. S. B.), L. Aug. (F. S.).

MICRODON TRISTIS Loew.

Sunburst (=*Canton*), June (F. S.). Larvæ collected at Raleigh in February, 1916, by Mr. C. S. Brimley from a decaying log at the edge of a pond were reared by the writer, the adults emerging about the middle of March. Mr. Brimley concluded from the very wet habitat that the larvæ could hardly have been associated with ants. However, the presence of a single ant among the material forwarded probably indicates that the ants had been present and were mostly driven away by the water, leaving these synokoetes behind.

OHIO STATE UNIVERSITY,
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ON THE OCCURRENCE AND DISTRIBUTION OF POTASSIUM IN NORMAL AND NEPHROPATHIC KIDNEY CELLS.[1]

By Wm. deB. MacNider.

The observations which are contained in this summary are based on the microchemical demonstration of potassium in the kidney cells of thirty-four dogs. The animals have varied in age from four months to something over ten years. Four of the animals may be grouped as "normal animals." They did not receive any nephrotoxic substance and neither were they subjected to the action of an anesthetic. After a period of three days of observation these animals were killed by shooting.

The remaining thirty animals were rendered nephropathic by uranium nitrate in the dose of 4 mg. or 6.7 mg. per kilogram. They were anesthetized by either Gréhant's anesthetic in 60 per cent strength, or by morphine-ether.

At the termination of the experiment small pieces of kidney tissue were removed, and frozen sections not over 20 micra in thickness were made. The sections were treated at once with Erdmann's[2] reagent as modified by Macallum[3] and used by him in his studies "On the Distribution of Potassium in Animal and Vegetable Cells."

The reagent which consists in a solution of the hexanitrite of cobalt and sodium serves as a complete precipitant of potassium from its solutions, in the form of an orange-yellow precipitate of the triple salt. If the salt is present in minute quantities the crystalline form is absent. To render the detection of small quantities of the salt possible, Macallum[3] used ammonium sulphide to react with the cobalt of the salt and form the black sulphide of cobalt, which is easily detected. This suggestion of Macallum's has been employed in the demonstration of potassium in all of the sections.

The results which have been obtained are as follows:

1. The epithelial cells of the normal dog kidney show only traces

[1]Reprinted from the Proceedings of the Society for Experimental Biology and Medicine, 1915, xiii, p. 10-12. Aided by a grant from the fund for scientific research of the American Medical Association.

[2] "Anorganische Chemie," 1898, p. 630. Reference given by Macallum.

[3] *Jour. Phys.*, Vol. XXXII, No. 2, p. 98.

of potassium. The potassium is most marked in the loops of Henle and is fairly evenly distributed throughout the cytoplasm of the cells. It has never been demonstrated within the nucleus of the normal cell.

2. The epithelium of the nephropathic kidney shows an increase in potassium over that of the normal. The potassium differs in distribution within the cytoplasm of the cell and has been demonstrated within the nucleus of the cell.

3. The potassium in the nephropathic organs has been especially marked in the cells of the convoluted tubules. In the cytoplasm of the cells forming these tubules the potassium is not uniformly distributed but is found to collect along the free margin of the cells bordering the lumen of the tubule. A similar observation on the distribution of potassium salts was first made by Macallum[1] in his studies of the frog kidney in which a decinormal solutions of potassium chloride was injected into the dorsal lymph sacs of frogs.

4. Such accumulations of potassium salts are as marked in the kidney epithelium of nephropathic animals which are polyuric as they are in the nephropathic animals which have been rendered anuric.

5. The above observation would tend to minimize the importance of potassium in being responsible for a lack of function on the part of the kidney.

6. The age of the animal has apparently no constant influence on the amount of potassium microchemically demonstrable. However, the oldest animal of this series showed the most marked potassium precipitate. In this animal, and one other of the series, which were anuric from uranium, and in which the epithelium of the convoluted tubules had undergone a severe swelling and partial necrosis, not only did the cytoplasm of these cells give the potassium reaction but potassium was also demonstrated in the nucleus of the cell.

CHAPEL HILL, N. C.

[1] *Science*, Vol. XXXII, No. 824, p. 497.

PROFESSOR CAIN'S CONTRIBUTIONS TO THE SCIENTIFIC STUDY OF EARTH PRESSURE: A PIONEER WORK*

ARCHIBALD HENDERSON.

The important work by Professor Cain, which has recently appeared, breaks new ground and lays the foundation for important advances by future scientists. The theories of earth pressure here set forth with particularity, and developed in detail, apply not only to earth supposed to be endowed with friction alone, but also for earth endowed with both friction and cohesion. The importance of this may be recognized in view of the fact that from the time of Coulomb down to the present, cohesion in earth has been neglected—notably by famous investigators like Poncelet and Weyrauch, who accepted Coulomb's hypothesis, and by the noted English engineering authority, Rankine.

I.

The first treatise dealing specifically with coherent earth was that of Résal, toward the close of the year 1910.[1] Before this, the subject had been ignored, except for the solution of the simplest case by Scheffler, that of the pressure on a vertical plane in an indefinite mass of earth with a horizontal surface. It is significant that even this attempt at a solution was shown to be incorrect by Professor Cain in his elaborate paper entitled "Experiments on Retaining Walls and Pressure on Tunnels."[2] Professor Cain set forth the correct interpretation of Scheffler's result in this paper, which was first published in January, 1911,[3] although not finally published, with accompanying discussions by other engineers, in the "Transactions" until the following June. This is a chronological detail of scientific importance, for Professor Cain's conclusions appeared simultaneously with Résal's treatise, and for the simple case treated by Cain, Résal's conclusions agreed with those of Cain. Attention should also be called

**Earth Pressure, Retaining Walls and Bins.* By William Cain. John Wiley & Sons, Inc., New York. 1916.

[1]*Poussee des Terres, II.* "Terres Cohérentes."

[2]Transactions Am. Soc. C. E., Vol. LXXII (1911).

[3]"Proceedings," Am. Soc. C. E.

to the fact that in this paper Cain, for the first time, gave a complete *graphical* method for finding pressures on any plane in a mass of earth endowed with both friction and cohesion ("coherent earth"), which method is set forth in the present work.

Hitherto no investigation has developed any sort of general graphical method. Consequently the volume under discussion is unique in this respect. This is a striking and valuable feature of the book, as it displays the superiority of Cain's researches in this respect to those of Résal. This is demonstrated by the fact that while the graphical method is applicable in all generality, the problem cannot be solved by Résal's analytical method when the earth's surface is not one plane. Moreover, the pressure against retaining walls, when wall-friction is included, is likewise not amenable to treatment by the analytical method of Résal. Cain's graphical method also lends itself easily to the estimation of the pressure against the bracing in trenches.

The final formulas deduced by Résal were traversed subsequently by Cain, who employed a method somewhat analogous, yet involving a different independent variable. The four different cases (two for active thrust and two for passive thrust) were thereby treated separately, conducive to much simplification. On the other hand, Résal combines all four cases in one solution; but this treatment, while commendable on the score of generality and precision, renders the analysis difficult and obscure. On the whole, Résal's entire treatment is full of difficulties even for the trained mathematician and engineer.

II.

Owing to the fact that this purely analytical treatment which he had employed resulted in equations too cumbrous for practical use, except in the simple case of earth level at top, Cain did not publish his analytical results, but approached the problem anew through the intermediary of Mohr's "Circular Diagram of Stress," which Professor Basquin had utilized in his notable paper on "Internal Friction," etc.[4] After demonstrating the principles relating to the "circular diagram of stress" by an independent investigation, Cain then applied this diagram method to the subject of coherent earth. It not

[4]Western Soc. C. E., Sept. 9, 1912.

only offered the very simplest solution, but afforded a practical solution for the general case of the surface sloping at any angle—a fact already pointed out by Basquin in his paper, already referred to. This method gave the unit pressures at any depth and the *surfaces of rupture,* which are curved, except in the case of the horizontal surface, when they are planes. By means of this treatment, formulas were easily deduced for active or passive thrust for earth surface horizontal and for depth at which the thrust is zero, greatest depth for equilibrium, etc.

The results for coherent earth appear in Chapter V of the volume under review—which also contains an original treatment of "Pressures on Tunnel Linings" for dry or saturated earth, based in part on Janssen's "bin theory"; and the subject of "heaving" in foundations, leading to the formulas given by Bell, who employed a different method, yet one awkward in the handling.

The treatment of coherent earth in Chapter V is assuredly one of the distinguishing features of the work. It is the first and only treatment of coherent earth in English and is totally different from Résal's method, although leading to the same results. The checks upon the accuracy of the results are amply afforded, both by Résal's analysis and by Cain's analytical method which as yet remains unpublished.

III.

To make a survey of the contents of the book, the laws of friction and cohesion of earth are fully stated in Chapter I, which also contains tables of the few coefficients thus far found experimentally.

In the "Proceedings Am. Soc. C. E." for December, 1915, Professor Cain strongly pressed the urgent need for "extensive experimentation." In answer to this strong plea, the sub-committee on earth pressures have offered to carry on the experimentation so urgently needed at the Pittsburg laboratory of the U. S. Bureau of Standards. The theory of coherent earth cannot, of course, be applied in practice until, for the earth in question, the simultaneous coefficients of friction and cohesion are found. No wholly satisfactory mechanical apparatus for effecting this has yet been devised—

the defects being pointed out by Professor Cain in his "closure" on his paper to be published in "Proceedings Am. Soc. C. E." for August, 1916.

IV.

The remaining chapters of the book deal with earth, supposed to be devoid of cohesion, as in the case of dry sand, gravel or rip-rap—the "granular material" of the usual theories. The Rankine theory is almost universally used in England and America, although it strictly applies only to a limitless granular mass with a plane upper surface. In such a mass, subjected to no force but its own weight, the pressure on a vertical plane acts parallel to the surface.

This theory is very fully treated by two independent methods. In Chapter III, Art. 48, the Rankine formula is found by aid of the sliding wedge hypothesis, in Art. 59 by use of the "ellipse of stress." In Art. 65, Professor Cain derives in an original and simple way formulas for determining the planes of rupture.

In Chapter I the direction of the pressure against a rough retaining wall is fully investigated—a subject neglected in other books written in English. In this way it is clearly demonstrated that the Rankine method is strictly inapplicable to finding the earth pressure against a retaining wall except in certain cases.[5] From the time of Poncelet, the French have allowed for wall-friction, as has the present author. The most noted French authors—Boussinesq and Résal—follow this lead, though they assume (for the sake of simplicity in the calculations merely) that the friction of earth on wall is the same as that of earth on earth. This cannot be true when the wall has a plane interior surface and is lubricated with water from rains. Cain includes this case and makes out all the tables for thicknesses of the various types of retaining walls, as given on pages 110 to 124, on this basis.

In Chapter II complete graphical methods for finding earth pressure are given, these being based in part upon Eddy's constructions in his "Graphical Statics"; also testing and design of walls. The important case of "the limiting plane" is fully discussed. It is the

[5] Cf. p. 51, figures 14 and 15.

only treatment of this important practical subject ever given. It agrees with the limited results of Résal and Boussinesq, derived by an independent, indirect process.

In Chapter III the sliding-wedge hypothesis is again used to deduce formulas for earth thrust, as well as shorter graphical methods. The author here follows the line of his own treatment, first given by him in his "Practical Designing of Retaining Walls." The treatment in the work under review is superior in arrangement and more comprehensive in scope.

In Chapter IV the designing of walls of types 1 to 5, etc., has already been alluded to. Here the design of usual types of reinforced concrete walls is taken up in great detail (pages 124-167). The estimation of earth is only one phase of the subject. Properly to discuss the toes, heels or counterforts, the "Theory of Wedge-shaped Reinforced Concrete Beams" had to be entered into, as given in Appendix I. The two theories submitted are approximations, since no practical exact theory is possible; and the treatment is complete for stresses due to bending, shear or band stresses. In justice to the author it should be explicitly stated that this appendix and its applications in Chapter IV constitute a distinctive and entirely original feature of the work.

In Chapter VI the usual Janssen bin theory, for "deep bins," is given and applied. No exact theory for "shallow bins" can be devised, it would appear, and each of the four (approximate) theories given is open to criticism. Still, in the case of the symmetrical hopper bin, coal heaped, the results are almost free from criticism; and, fortunately, this is the design nearly always met with in practice. Similarly, the graphical solution given for the "unsymmetrical bin" (page 232) is moderately satisfactory; indeed, it is the first rational solution ever given of this case.[6]

In Appendix II the author has set forth a few of the results of experiments on model retaining walls, with discussion, extracted from his own elaborate paper, entitled, "Experiments on Retaining Walls," etc." *Trans. Am. Soc. C. E.*, Vol. LXXII, 1911.

[6]Professor Cain has pointed out that Ketchum's treatment is ludicrous, being in actual violation of the laws of statics.

In view of the particularity with which the contents of the book have been described above, it is unnecessary, in summary, to say more than this: that Professor Cain in this work has rendered a conspicuous service to the engineering profession in the United States, and given powerful impetus to a subject of permanent and rapidly growing importance. For this, the country and the American engineer owe him a genuine debt of gratitude.

A CORRECTION.

In a "List of Plants Growing Spontaneously in Henderson County, N. C.," published in this Journal January, 1915, *Prunus umbellata* Ell. was included. This is an error and it should, therefore, be stricken from the list.

ED. R. MEMMINGER.

FLAT ROCK, N. C., June 12, 1916.